1. A projection optical system, comprising:

at least one lens;

at least one concave mirror;

at least one diffractive optical element;

a first imaging optical system, having said at least one lens and said at least one concave mirror, for imaging an intermediate image of an object;

a second imaging optical system, having said at least one lens and said at least one diffractive optical element, for projecting the intermediate image onto an image plane; and

a field optical system disposed between said first and second imaging optical systems.

2. A projection optical system according to Claim 1, wherein said at least one lens, said at least one concave mirror and said at least one diffractive optical element have a positive refractive power, respectively, and wherein said projection optical system does not include a lens having a negative refractive power, a mirror having a negative refractive power, a mirror having a negative refractive power or a diffractive optical element having a negative refractive power.

3. A projection optical system according to Claim 1, wherein said at least one lens, said at least one concave mirror and said at least one diffractive optical element include a lens, a concave mirror and a diffractive optical element of a positive refractive power.

5. A projection optical system according to Claim 1, wherein said first and second imaging optical systems are disposed along a common straight optical axis, and wherein abaxial light from the object as reflected and collected by said concave mirror is caused by said mirror to pass through an outside portion of an effective diameter of said concave mirror, toward the image plane side.

7. A projection optical system according to Claim 5, wherein said first imaging optical system includes at least a lens having a positive refractive power, a reflection mirror and said concave mirror, which are disposed in the order mentioned above, from the object side.

8. A projection optical system according to Claim 7, further comprising a lens group disposed between said reflection mirror and said concave mirror.

9. A projection optical system according to Claim 8, wherein said lens group has a negative refractive power and is disposed between said concave mirror and a lens, in said first imaging optical system, having a positive refractive power.

10. A projection optical system according to Claim 1, further comprising a reflection surface disposed adjacent to an intermediate image formed by said first imaging optical system, and wherein abaxial light from the object as reflected and collected by said concave mirror is deflected by said reflection surface toward said second imaging optical system.

11. (Amended) A projection optical system according to Claim 1, wherein at least one of said at least one diffractive optical element of said projection optical system satisfies a relation:

$$3 < MP/\lambda < 50$$

where MP is a minimum pitch (micron) of the diffractive optical element, and λ is the exposure wavelength (micron).

12. (Amended) A projection optical system according to Claim 1, wherein at least one of said at least one diffractive optical element of said projection optical system satisfies a relation:

$$|Ld/Lg2| < 0.2$$

where Ld is the distance between an aperture stop of said second imaging optical system and said diffractive optical element, and Lg2 is the distance from a paraxial image plane position of an intermediate image formed by said first imaging optical system, corresponding to an object point position of said second imaging optical system, to a re-imaging plane where the intermediate image is re-imaged.

13. (Amended) A projection optical system according to Claim 3, further comprising a field stop adjacent to an intermediate image to be formed by said first imaging optical system.

37. A projection optical system, comprising:

at least one lens;

at least one concave mirror;

at least one diffractive optical element;

a first imaging optical system having said at least one lens and said at least one concave mirror, for imaging an intermediate image of an object, wherein said first imaging optical system includes at least a lens having a positive refractive power, a reflection mirror and said concave mirror, which are disposed in the order mentioned above, from the object side; and

a second imaging optical system having said at least one lens and said at least one diffractive optical element, for projecting the intermediate image onto an image plane,

wherein said first and second imaging optical systems are disposed along a common straight optical axis, and wherein abaxial light from the object as reflected and collected by said concave mirror is caused by said mirror to pass through an outside portion of an effective diameter of said concave mirror, toward the image plane side.

38. A projection optical system according to Claim 37, wherein said at least one lens, said at least one concave mirror and said at least one diffractive optical element have a positive refractive power, respectively, and wherein said projection optical system does not include a lens having a negative refractive power, a mirror having a negative refractive power, a mirror having a negative refractive power or a diffractive optical element having a negative refractive power.

39. A projection optical system according to Claim 37, wherein said at least one lens, said at least one concave mirror and said at least one diffractive optical element include a lens, a concave mirror and a diffractive optical element of a positive refractive power.

40. A projection optical system according to Claim 37, further comprising a field optical system disposed between said first and second imaging optical systems.

41. A projection optical system according to Claim 37, further comprising a lens group disposed between said reflection mirror and said concave mirror.

42. A projection optical system according to Claim 41, wherein said lens group has a negative refractive power and is disposed between said concave mirror and a lens, in said first imaging optical system, having a positive refractive power.

43. A projection optical system according to Claim 37, further comprising a reflection surface disposed adjacent to an intermediate image formed by said first imaging optical system, and wherein abaxial light from the object as reflected and collected by said concave mirror is deflected by said reflection surface toward said second imaging optical system.

44. (Amended) A projection optical system according to Claim 37, wherein at least one of said at least one diffractive optical element of said projection optical system satisfies a relation:

$$3 < MP/\lambda < 50$$

where MP is a minimum pitch (micron) of the diffractive optical element, and λ is the exposure wavelength (micron).

45. (Amended) A projection optical system according to Claim 37, wherein at least one of said at least one diffractive optical element of said projection optical system satisfies a relation:

$$|Ld/Lg2| < 0.2$$

where Ld is the distance between an aperture stop of said second imaging optical system and said diffractive optical element, and Lg2 is the distance from a paraxial image plane position of an intermediate image formed by said first imaging optical system, corresponding to an object point position of said second imaging optical system, to a re-imaging plane where the intermediate image is re-imaged.

46. (Amended) A projection optical system according to Claim 39, further comprising a field stop adjacent to an intermediate image to be formed by said first imaging optical system.

Please ADD new claims 47-55 as follows:

-- 47. A projection optical system according to Claim 1, wherein said at least one lens, said at least one concave mirror and said at least one diffractive optical element have a positive refractive power, respectively, and wherein said projection optical system does not include a lens having a negative refractive power, a mirror having a negative refractive power, a mirror having a negative refractive power or a diffractive optical element having a negative refractive power.

48. A projection optical system according to Claim 1, wherein said at least one lens, said at least one concave mirror and said at least one diffractive optical element include a lens, a concave mirror and a diffractive optical element of a positive refractive power.

49. A projection optical system according to Claim 1, wherein said projection optical system includes a first imaging optical system having said at least one lens and said at least one concave mirror, for imaging an intermediate image of an object; and

a second imaging optical system having said at least one lens and at least one diffractive optical element, for projecting the intermediate image onto an image plane.

50. A projection optical system according to Claim 49, wherein said first and second imaging optical systems are disposed along a common straight optical axis, and wherein abaxial light from the object as reflected and collected by said concave mirror is caused by said mirror to pass through an outside portion of an effective diameter of said concave mirror, toward the image plane side.

51. A projection optical system according to Claim 49, further comprising a reflection surface disposed adjacent to an intermediate image formed by said first imaging optical system, and wherein abaxial light from the object as reflected and collected by said concave mirror is deflected by said reflection surface toward said second imaging optical system.

52. A projection optical system according to any one of Claim 1, wherein at least one of said at least one diffractive optical element of said projection optical system satisfies a relation:

$$3 < MP/\lambda < 50$$

where MP is a minimum pitch (micron) of the diffractive optical element, and λ is the exposure wavelength (micron).

53. A projection optical system according to any one of Claim 1, wherein at least one of said at least one diffractive optical element of said projection optical system satisfies a relation:

$$|Ld/Lg2| < 0.2$$

where Ld is the distance between an aperture stop of said second imaging optical system and said diffractive optical element, and Lg2 is the distance from a paraxial image plane position of an intermediate image formed by said first imaging optical system, corresponding to an object point position of said second imaging optical system, to a re-imaging plane where the intermediate image is re-imaged.

54. A device manufacturing method, comprising the steps of:

exposing a wafer to a device pattern using a projection optical element system according to Claim 48; and

developing the exposed wafer.